METROPOLITAN TRANSPORTATION COMMISSION

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ASSOCIATION OF BAY AREA GOVERNMENTS

Regional Airport Planning Committee

February 9, 2007

TO: Regional Airport Planning Committee
FROM: Staff of the Regional Airport Planning Committee

SUBJECT: Panel on New Air Traffic Control and Management Technology

Background. The first phase of the work plan approved by the Committee for reviewing the Regional Airport System Planning Analysis (RASPA) includes four informational panels. In January, RAPC heard a panel of experts speak about future aviation trends. The February panel will address new air traffic control and management technologies that could improve the future safety and operational efficiency of the Bay Area's airports and airspace.

Findings from the 2000 RASP. The 2000 Regional Airport System Plan (RASP) employed a two-pronged approach for analyzing airport and airspace capacity. A detailed computer simulation of the Bay Area's airport system was conducted for different possible new runway configurations at SFO and OAK using the aviation activity forecasts for 2010 and 2020. The model simulated good and bad weather flight operations in the 50 mile terminal airspace around the Bay Area airports (Figures 1 and 2) and produced estimates of total aircraft delays for the individual airports and entire airspace. The model was also used to test new poor weather operational procedures at SFO, as well as a set of conceptual demand management strategies for all airports.

Second, various experts were consulted on the potential benefits of new air traffic control technologies, including RAPC's own consultant and representatives from the FAA and NASA.

Based on this analysis, the 2000 RASP contained the following findings and conclusions:

- In addition to having existing delay problems in bad weather, SFO would begin to experience good weather capacity problems by 2010. Due to a combination of high traffic levels and a significant number of poor weather days that reduced runway capacity at SFO, the delays experienced at SFO during the time that the RASP was being updated in 2000 were some of the highest in the nation.
- OAK would face both good and bad weather capacity problems starting in 2010.
- SJC, with the completion of a second air carrier runway that was then under construction, would not experience capacity problems before 2020.
- Runway capacity at the commercial airport runways, not airspace capacity, was identified as the limiting capacity factor in determining how much demand the three Bay Area commercial airports could handle in the future.

- In 2000, it was found that there was no new technology on the horizon that could provide Visual Flight Rule (VFR) -like (i.e., good weather) capacity for SFO's runways during bad weather. This was because of the close lateral runway spacing (750 ft.) which precludes simultaneous aircraft landings in most bad weather conditions and because of the need to provide gaps in the aircraft arrival stream to allow departures to take place on the other set of crossing runways.
- SFO's runway performance during poor weather would be enhanced if a new procedure (Simultaneous Offset Instrument Approach (SOIA) using a Precision Runway Monitor) were to be implemented. Arrivals could be increased from the single runway arrival rate of 30 aircraft per hour to 35-38 arrivals per hour under certain poor weather conditions.
- New technologies to improve airspace safety and efficiency would continue to evolve, relying primarily on orbiting satellites to provide Global Positioning Signal (GPS) signals that would precisely identify the location of aircraft down to several meters.
- In addition to benefiting operations at commercial airport, new technologies could expand the number of general aviation airports that would be accessible in adverse weather conditions.
- New air traffic controller tools (such as the FAA's Center-Terminal Radar Approach Control (TRACON) Automation System being evaluated at Dallas-Fort Worth) would enable aircraft arriving at Bay Area airports to be more efficiently sequenced for landing, reducing excess spacing. However, it was found that the results from the Dallas Fort Worth test may not be directly transferable to the Bay Area due to differences in the airspace design and airport configurations.
- It was found that the timeframe for implementation of many new technologies is often difficult to determine. New technologies can encounter unanticipated development problems, and require adequate time to ensure their reliability, accuracy, and safety. System users must buy in to the technologies (airlines, pilots, controllers, etc.) and liability issues must be resolved. Additionally, the costs of new programs can grow significantly, creating funding challenges both for the FAA and system users. Finally, because of the rapid pace of technological growth, technologies that were new at the outset can be overtaken by even better technologies mid-way through their development cycle.

Changes Since the Last RASP

Delays. Prior to, and during preparation of the 2000 RASP, SFO was experiencing some of the highest airline delays in the country. Following the recession in the early 2000's and 9/11, delays have moderated at SFO and the other Bay Area airports, primarily due to decreased traffic levels at SFO and SJC and more benign weather conditions (see Figures 3 and 4).

FAA Capacity Assessment of Airports. The FAA periodically evaluates the capacity needs of the nation's busiest airports in terms of both current and future conditions. The latest such evaluation published in June 2004, *Capacity Needs in the National Airspace System*, includes assessments for both OAK and SFO. The 2004 report, based on the FAA's Terminal Area Forecasts, projects that OAK could need additional airfield capacity by 2013 and SFO by 2015. A new, updated report will be released in the Spring of 2007.

New Northern California TRACON. In 2003 the FAA completed the transfer of air traffic control responsibilities from four TRACON facilities in Northern California--Oakland, Monterey, Sacramento, and Stockton--to the consolidated Northern California TRACON in Sacramento. This new TRACON monitors flights in and out of more than 20 airports. Travis AFB still maintains its own TRACON.

Center-TRACON Automation System. This computer automation tool assists air traffic controllers in descending, sequencing, and spacing aircraft arrivals from up to 200 miles from an airport. The tool is used by both the enroute air traffic control centers and the TRACONs. Using this tool, controllers can reduce excess spacing between aircraft to increase the effective capacity of the airspace and airport runways. The FAA continues to install this system at its air traffic control centers and TRACONs, with reported capacity gains of 3-5%.

New Instrument Landing Procedure for SFO. Between 1996 and 1998, the percentage of hours SFO operated with arrival rates of 30 aircraft or less due to poor weather ranged from 11% to 31%. The FAA's minimum runway separation standard for simultaneous instrument approaches to parallel runways in bad weather remains 3,400 ft. However, in 2004 the Simultaneous Offset Instrument Approach procedure was implemented at SFO for certain poor weather conditions (when cloud ceilings are 2,100 ft and higher and visibility is four miles or more), expanding the amount of time that both arrival runways can be used. As discussed above, airport arrival capacity increases from 30 to 35-38 aircraft per hour and even higher for short periods of time (See Figures 5 and 6).

Research on Runway Separation Requirements. Under current FAA rules, runways that are separated by less than 2,500 feet are treated as a single runway when applying safe wake vortex separation requirements. Thus, even in good weather, when two aircraft are staggered on their landing approach to SFO (i.e., are not landing side-by-side), they must be separated as if they were landing on the same runway. Based on wake vortex research the FAA has conducted at St. Louis International and other airports, it may be possible under specific wind conditions to allow reduced spacing of aircraft arriving on closely spaced parallel runways. This would apply both to good and bad weather operations, but may need to be coupled with advanced wake vortex surveillance systems. The FAA's latest research could lead to a new proposed Air Traffic Control rule, providing for parallel dependent Instrument Landing System approaches to runways as little as 1,200 feet apart. Changes in these requirements would not increase capacity at SFO's runways which are only 750 feet apart.

A Vision for the Future. The nation's air traffic control and management system is constantly evolving. The goal of the current FAA program, called the Next Generation Air Transportation System (NGATS), is to be able to handle a threefold increase in traffic by 2025. New technologies will rely heavily on satellite-based navigational systems, as opposed to the current system which relies on ground-based radar. While the focus of NGATS is on the performance of the national airspace, rather than on fixing capacity problems at individual airports, the new technologies will support programs to improve capacity at individual airports. These new technologies will incrementally change the nation's air traffic system from today's centralized command–and–control type system to one in which controllers and pilots have a more collaborative decision making relationship (i.e., a greater shift of aircraft routing and separation responsibilities to the pilot). Technologies to automate and reduce controller workload will be particularly important, since over the next 10 years the FAA estimates that nearly 73% of the air traffic controllers will become eligible to retire.

Aided by satellite based navigation systems, pilots will choose their own routes between airports to save time, reduce fuel consumption, avoid bad weather, and minimize delays. Aircraft will not have to follow designated airways (highways in the sky) as they do today. Pilots will have technology in the cockpit to "see" other aircraft allowing them to safely separate themselves from these aircraft, both in the enroute airspace and in the terminal areas around airports.

The air traffic control system will also keep track of every aircraft's flight plan in 4-D (location and time), and will precisely know where all aircraft are in the airspace and their exact arrival path and touchdown time at the destination airport. The air traffic control system will constantly adjust paths as necessary for weather conditions, traffic loads at congested airports, etc.

The air traffic control system will allow multiple arrival and departure routes to be defined for each airport using Global Positioning System (GPS) technology. The routes may be curved to provide greater separation in the air, avoid noise sensitive areas on the ground, avoid obstacles in the airspace, etc. Aircraft will be sequenced for landing using automated tools to optimize the use of airspace and reduce excess spacing (due to wing vortex separation requirements between small, medium and heavy aircraft). More and more aircraft will use a minimum fuel consumption approach to airports, called continuous descent, following a constant glide slope from a certain altitude to runway touchdown. The continuous descent technique will reduce both fuel consumption and noise impacts.

The package of new technologies may allow simultaneous instrument approaches in bad weather to runways that are closer than 3,400 ft. apart (the current minimum FAA standard), as pilots will be able to "see" the position of other nearby aircraft, weather ahead of them, the outline of the intended landing runway, even the propagation of wake vortices from aircraft ahead of them. Pilots will use this information to maintain a safe distance from other aircraft around them while landing on single or parallel runways. This type of technology would prolong the time when visual or visual-like approaches can be used at an airport, thus reducing flight delays (i.e. cut down the duration of instrument operations). It would also enable aircraft landing in-trail on a single runway (like OAK) to safely reduce the distance between aircraft.

All-weather access to general aviation airports will be improved by new GPS based navigation systems, and some Bay Area general aviation airports will gain new precision instrument approaches. This will aid both personal and business general aviation users and help serve the projected increase in use of Very Light Jets.

Ground-based radars will be used initially to provide redundancy for GPS navigation systems, but will eventually be decommissioned, saving the FAA money.

Attachment A discusses some of the key enabling technologies that will make this vision a reality.

The Panel. Staff has assembled a panel of knowledgeable experts who will discuss advancements in new Air Traffic Control and Management Technologies.

- **Andy Richards (FAA)-Moderator.** Mr. Richards was the moderator for the panel on Aviation Trends and will be the moderator for February's panel as well. He is the Manager of the FAA's San Francisco Airport District Office.
- **Dennis Sullivan (FAA).** Mr. Sullivan manages the SFO Tower and is an expert on air traffic operations at Bay Area airports. He will review existing technologies as well as new technologies that would likely be implemented in the next 10 years.
- **Tom Cornell (Jacobs Consultancy).** Mr. Cornell will provide some examples of how other airports are addressing their capacity issues and how existing technologies could be used in innovative ways.
- **Monica Alcabin (The Boeing Company).** Ms Alcabin will be discussing the costs and benefits of new air traffic control technologies and the challenges of integrating new technologies into today's air traffic control system.

- **Harry Swenson (NASA).** Mr. Swenson is the principal investigator for NASA's research to support the FAA's Next Generation Air Transportation System. He will discuss the potential and realities of research in Air Traffic Management Technologies.
- **Donald Crisp (ATAC).** Under contract with SFO, Mr. Crisp has been evaluating potential benefits of new technologies that could help with SFO's runway capacity issues, with a particular focus on potential improvements to the Simultaneous Offset Instrument Approach (SOIA) procedures.

Attachment B contains a biography for each panel member.

Sample Questions for the Panel. The projected growth in air travel and air cargo combined with existing constraints on poor weather airport capacity could lead to increasing airline delays in the future. In addition to inconvenience, delays cost the airlines and travelers money. As discussed by different panelists, technology can play a part in mitigating these future delays. Some sample questions for the panel are listed below:

- What will be the most beneficial technologies for the Bay Area in terms of increasing airport runway and airspace capacity?
- Are there innovative ways to apply existing technologies that could benefit the Bay Area without the need to wait for new technologies?
- Are there order of magnitude estimates for potential capacity gains from new technologies?
- Which technologies are near-term and which would require a very long time to develop and deploy?
- The FAA has continued to refine its collaborative decision-making process with the airlines to manage weather and other situations that cause widespread delays throughout the national airport system. Are there new strategies and tools being evaluated to provide even better delay management in the future?

Committee members are encouraged to bring their own questions to the meeting.

Next Steps. As reported at the last Committee meeting, after all four panels have been completed staff will summarize the information presented, provide draft findings, conclusions and recommendations, and discuss the implications of this information for the Committee's future work in Phase 2. The remaining panels are scheduled as follows:

- Demand Management: *Friday, April 27*
- Airport Governance and Institutions: *Friday, June 22*

Figure 1
Good Weather Plan

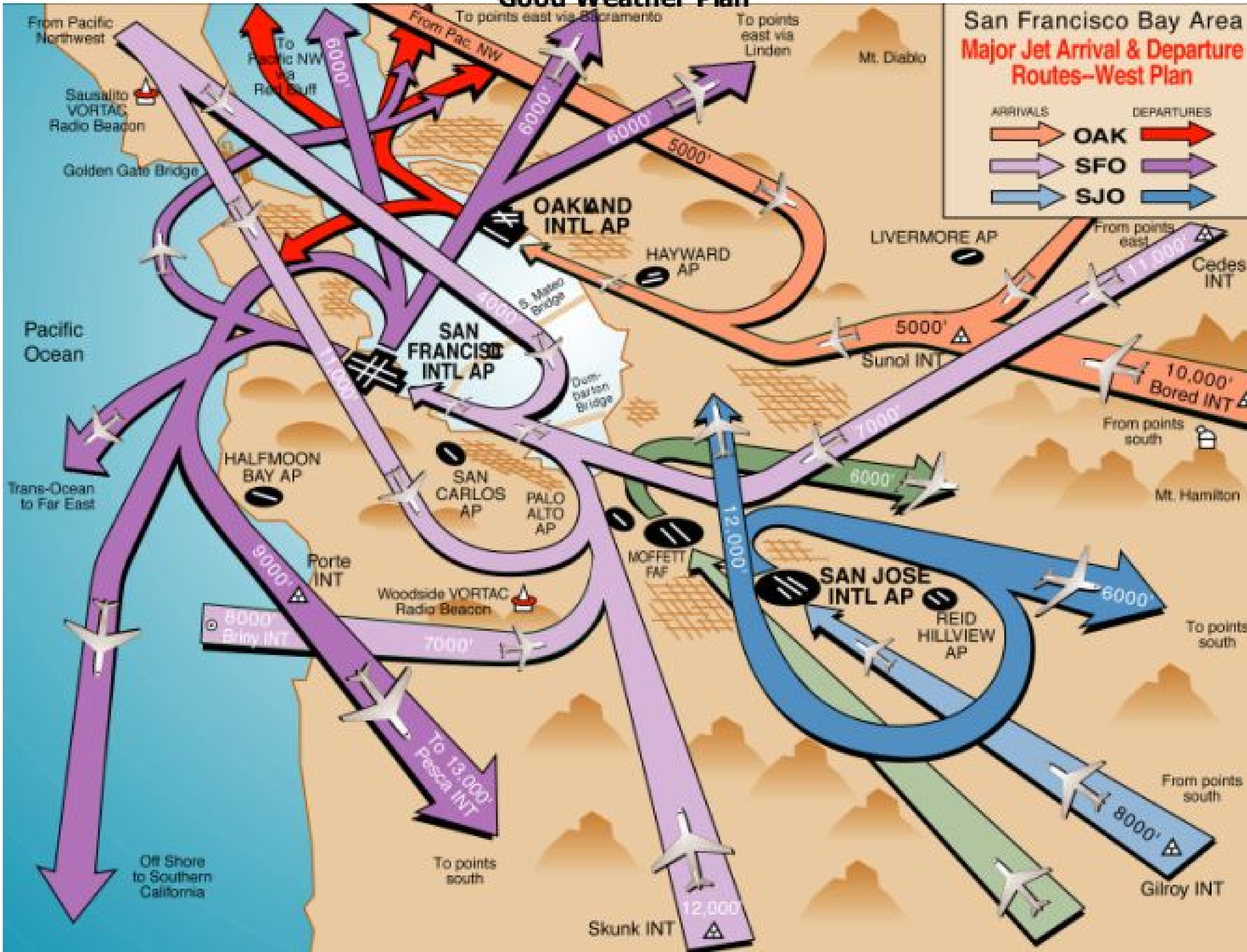


Figure 2
Poor Weather Plan

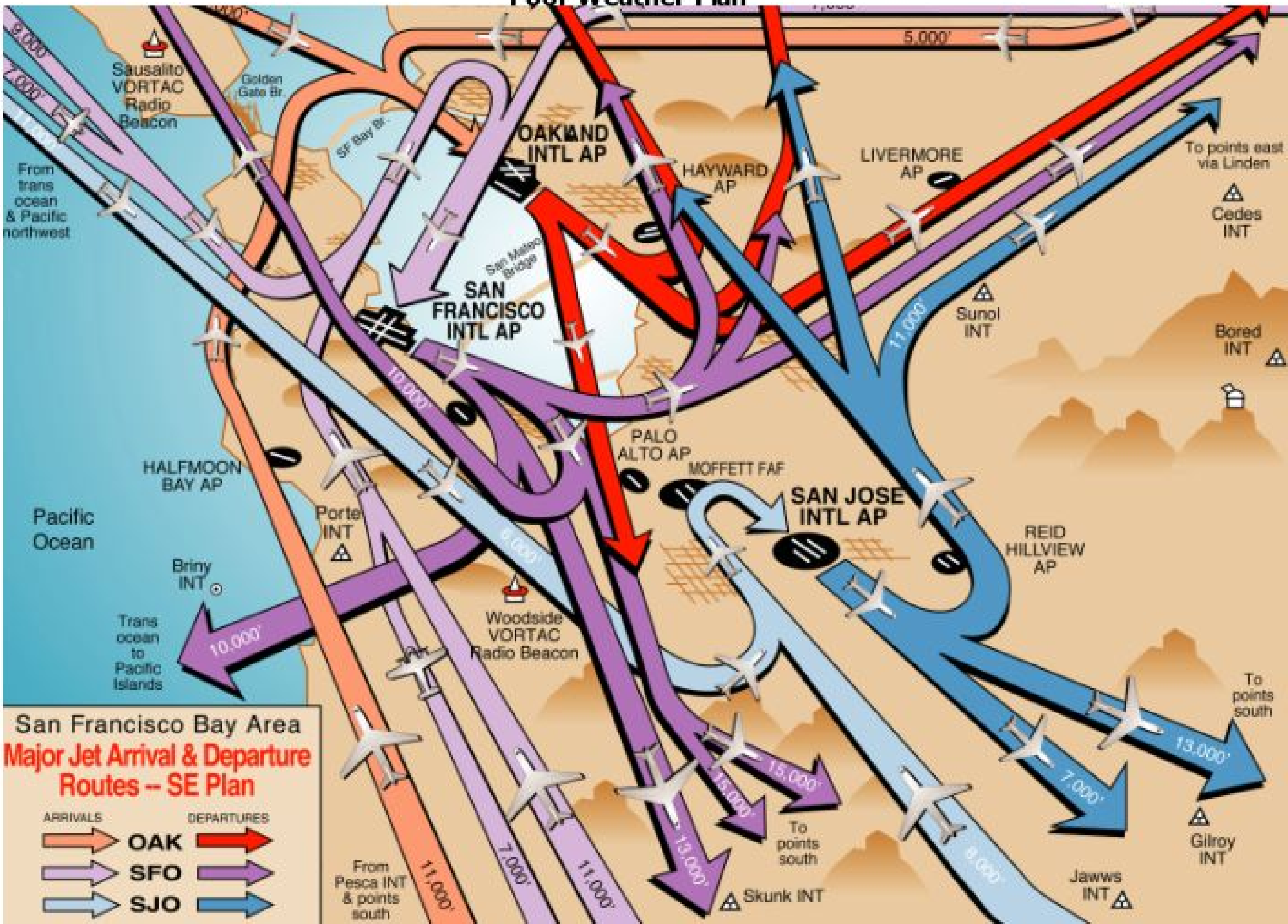


Figure 3

Measure: On-time Arrival (within 15 minutes of schedule)

Reporting Period: CY 1999-July 2005

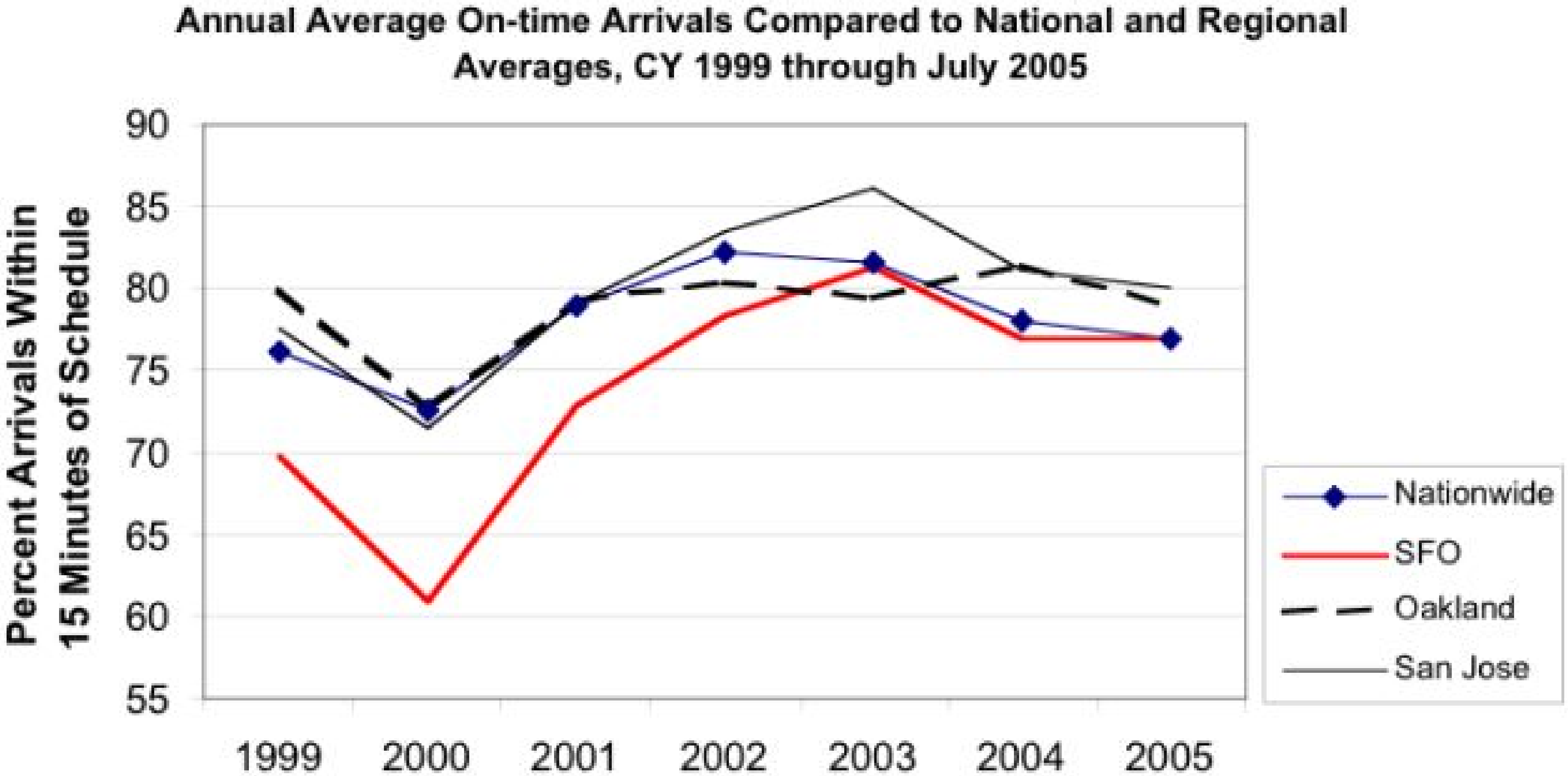


Figure 4

Measure: On-time Departure (within 15 minutes of schedule)

Reporting Period: CY 1999-July 2005

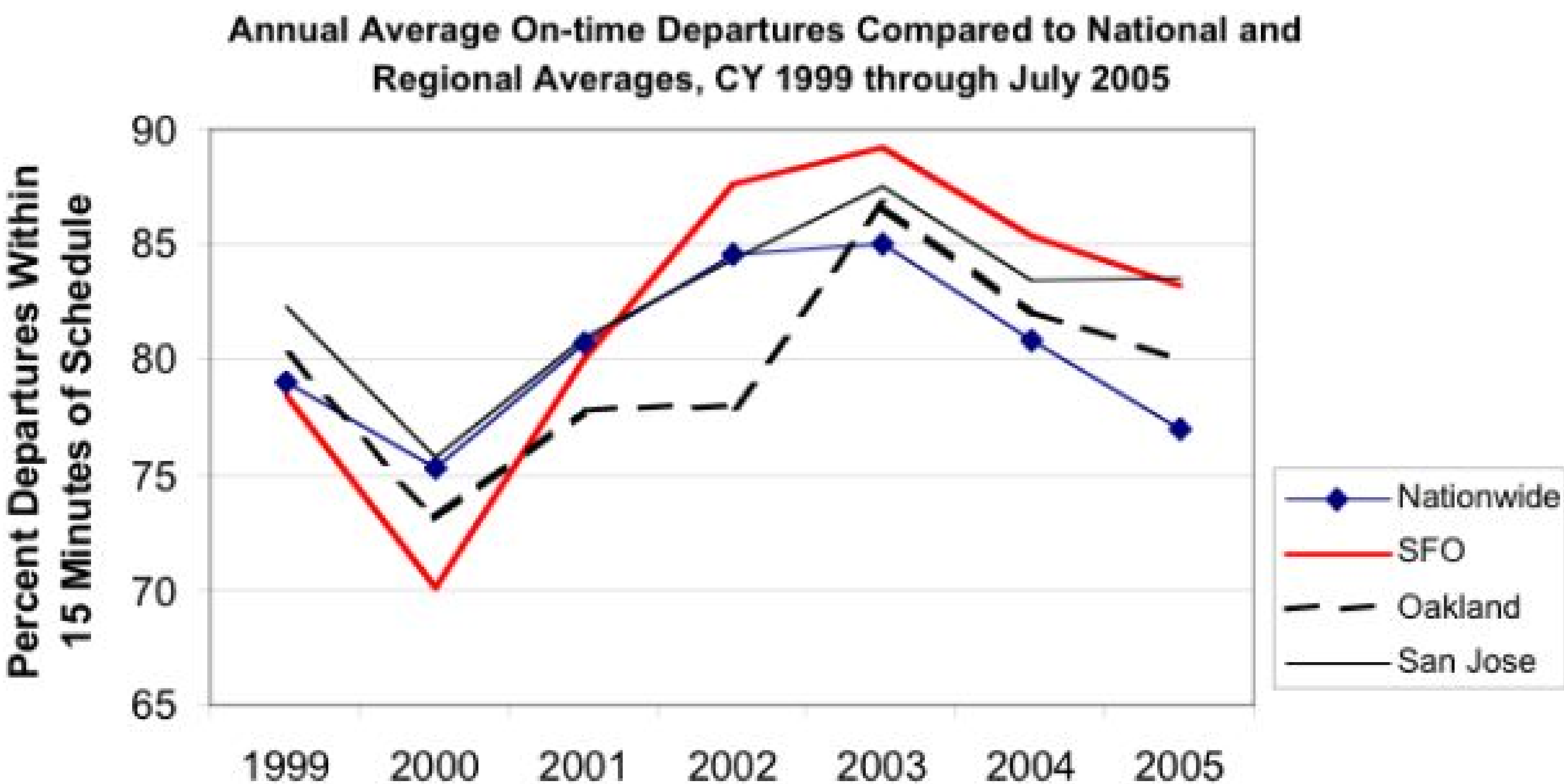


Figure 5

Today's In-Trail Instrument Approaches

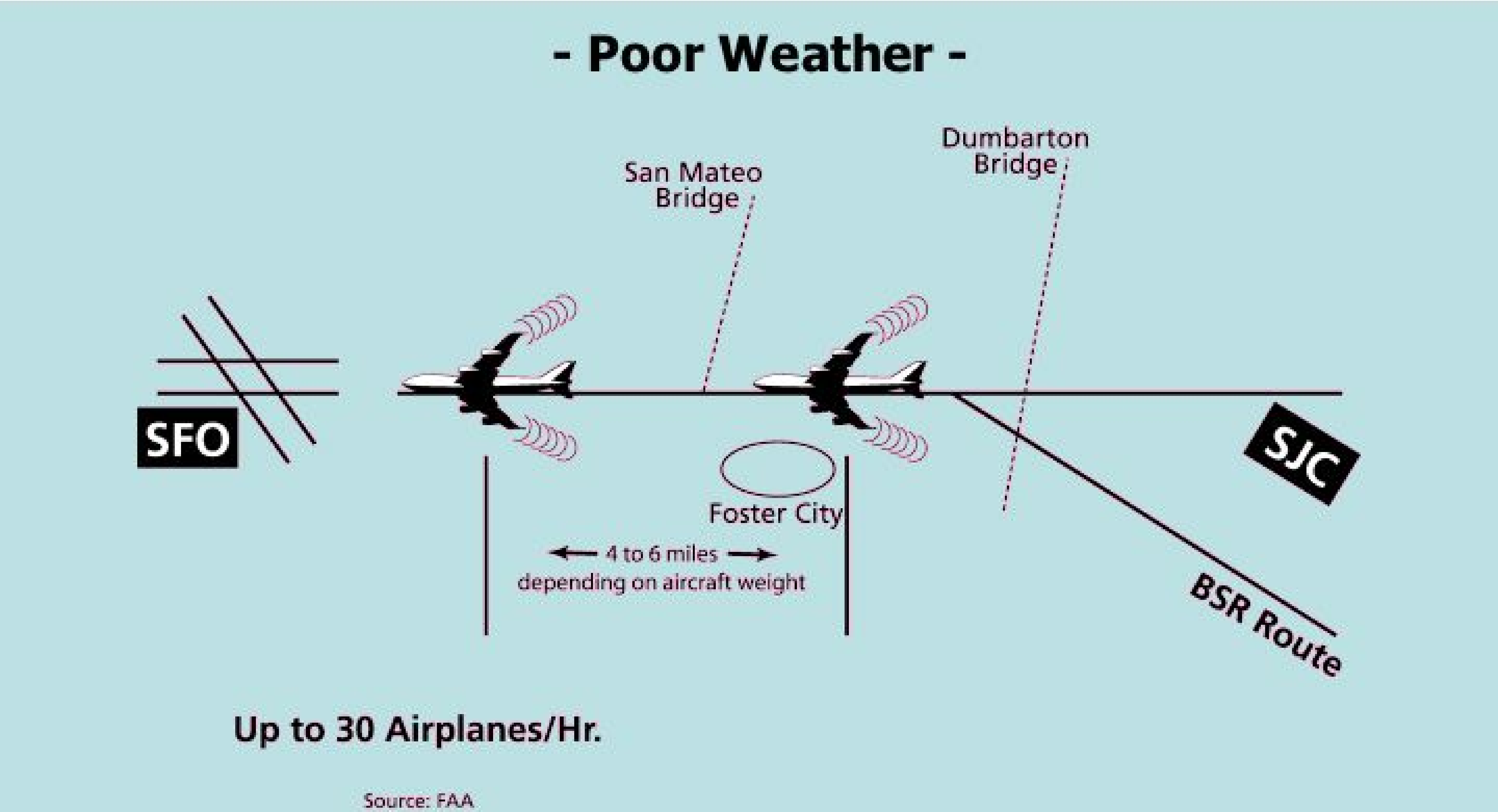
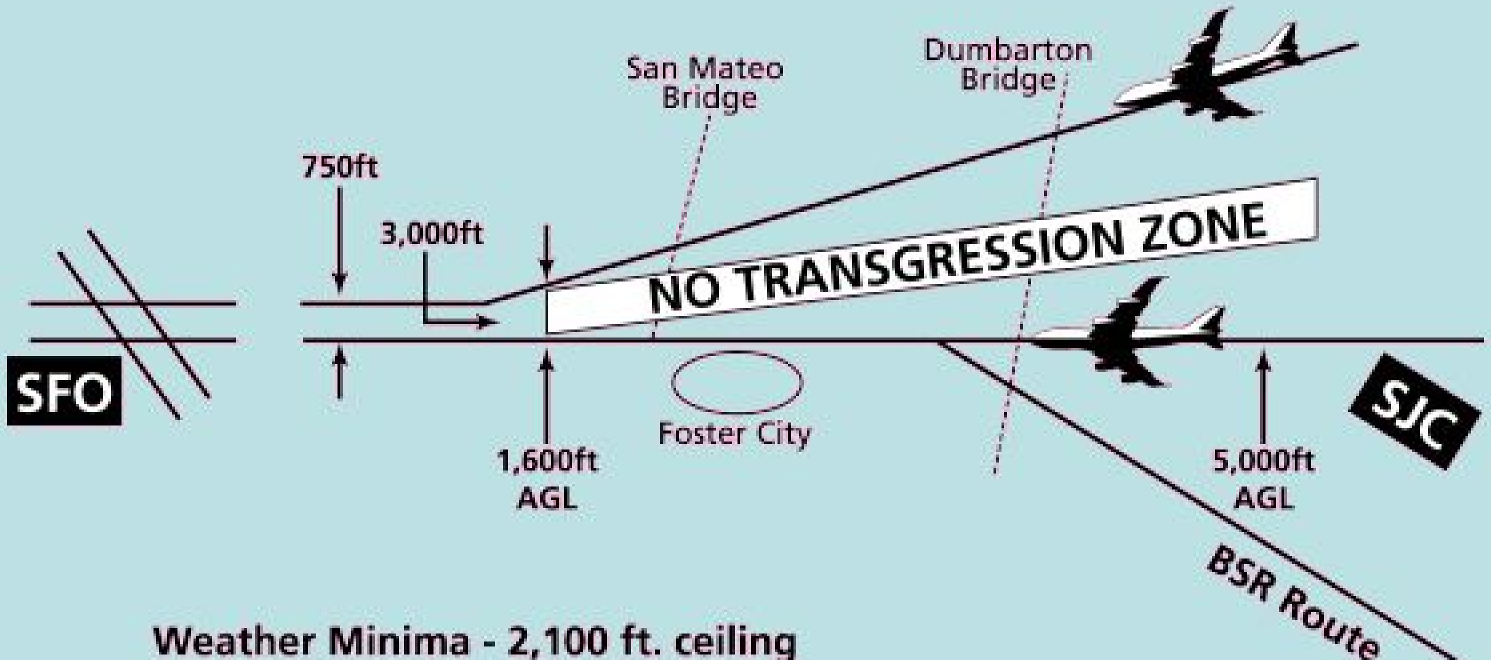


Figure 6

SOIA/PRM Operations

(Simultaneous Offset Instrument Approaches/ Precision Runway Monitor)



Weather Minima - 2,100 ft. ceiling
5 mile visibility

35-40+ Airplanes/Hr.

Attachment A
Enabling Technologies

Wide Area Augmentation Systems. These systems augment GPS satellite signals to provide more accurate horizontal and vertical position information to aircraft in all phases of flight (in route, airport arrivals, airport departures). It will eventually replace Category I instrument landing systems for poor weather operations and will extend Category I precision approaches down to 200 ft, a potential benefit for several of the region's major general aviation airports (Note: Category I, II, and III refer to increasingly poor weather conditions in terms of cloud ceiling and visibility, and define the types of instrument approaches that can be made to an airport based on the navigational aids at the airport, equipment onboard the aircraft, and pilot experience).

Local Area Augmentation Systems. This system further augments GPS satellite signals to provide the accuracy and integrity necessary for Category II/III instrument approaches to airports (approaches during the poorest of weather). Multiple curved approaches, not possible using current instrument landing systems, will be made possible. Portions of this program have reverted from development to more research being required.

Required Navigational Performance (RNP). RNP is not new hardware for the cockpit or ground based navigational aids. Rather, RNP is a system for defining navigational system accuracy and airspace containment to a very high degree, such that controllers can expect aircraft to be at a specific position with extreme confidence. With this level of accuracy, aircraft spacing can be reduced and safety improved. A combination of RNP and a precision runway monitoring system could permit simultaneous instrument approaches at more airports with closely-spaced parallel runways, provided issues such as GPS signal reliability, protection from centerline transgressions by aircraft, and aircraft wake vortex hazards can be resolved.

Automatic Dependent Surveillance-Broadcast (ADS-B). This is one of the linchpin technologies for the new era of air traffic control and management. Aircraft equipped with ADS-B will continuously broadcast their position, airspeed, altitude, and planned course changes to the ground and all aircraft around them. This information can then be displayed for controllers and pilots, providing a picture of area traffic. This "picture" of traffic will enable pilots to separate themselves from other ADS-B equipped aircraft and should result in capacity gains during Instrument Flight Rules (IFR) conditions at congested airports.

Simultaneous Offset Instrument Approach (SOIA). This procedure is used in certain poor weather conditions at SFO to land aircraft simultaneously on SFO's closely spaced parallel runways. It uses a Precision Runway Monitor (rapid update radar) to guard against aircraft airspace transgressions in combination with an offset Instrument Landing System and Localizer on SFO's main landing runways. Aircraft approach the airport on converging paths down to 2,100 ft at which point the two aircraft must be able to visually see each other for the remainder of their final approach or the approach must be discontinued. Future software enhancements to protect aircraft from wake turbulence may allow minimum ceilings to be lowered to 1,400 to 1,600 ft, expanding the time SOIA could be used, and further increasing capacity at SFO during poor weather conditions. Eventual transition from ground based radar to RNP may also provide new capacity gains, when used in conjunction with the wake vortex surveillance programs.

Wake Vortex Separation System. Aircraft wing tips generate turbulence, the strength of which is generally proportional to the weight/size of aircraft. If an aircraft following another aircraft encounters a strong wake, it can destabilize the aircraft in flight, with potentially disastrous consequences. Thus, controllers must space aircraft out on their final approach based on the size of the aircraft. At SFO, this separation is even applied in good weather between aircraft arriving on separate runways. A wake vortex detection and prediction system, which provides real time information for pilots and controllers, could increase airport capacity by reducing aircraft separation. The capability to detect wakes (through radar and acousto-optic techniques) and accurately predict their behavior is still a number of years away, given the safety and reliability levels that must be achieved. Some research has also been conducted on devices that could be installed on aircraft wings to help reduce the strength of a wing's vortex, but the current status of research in this area is unknown.

Attachment B

New ATC Technology Panel Biographies

Andy Richards. Mr. Richards is the Manager of the San Francisco Airports District Office (SFO ADO). He has occupied this position for nearly five years. His office is responsible for managing the Federal Aviation Airport Improvement Program for all the airports in Northern California and Nevada. The SFO ADO AIP program provides nearly $200 million dollars in funding each year for airport safety, security, and capacity improvements. Previously, Mr. Richards had 20 years of Air Traffic Control experience, 11 years in the Bay Area. Mr. Richards has been the Air Traffic Manager of Bay Terminal Radar Approach Control (TRACON), the FAA facility that is responsible for air traffic control in the entire Bay Area. He has been the Acting Air Traffic Manager at San Francisco Air Traffic Control Tower (ATCT), as well as the Assistant Air Traffic Manager at both Bay TRACON and San Francisco ATCT. He has experience in positions in the FAA Regional Headquarters and Air Traffic Control field supervisory responsibilities.

Mr. Richards has a Masters' Degree in Business Administration from Pepperdine University, as well as completing his undergraduate work at the University of California at Berkeley. He is married with two children, enjoys swimming from Alcatraz each year, basketball and being a "soccer and lacrosse dad".

Monica Alcabin. Ms. Alcabin has been with the Boeing Company for ten years and is an Associate Technical Fellow with the Boeing Commercial Airplane group. She has twenty-five years of experience analyzing a variety of aviation problems with particular emphasis on the benefits assessment of airport, airspace, and ATM operational enhancements that include a combination of new procedures and new Communication, Navigation, Surveillance/Air Traffic Management technologies.

For the past two years, she has been assisting the Joint Planning and Development Office (JPDO) Evaluation & Analysis Division by assessing the airport capacity benefits of the Next Generation Air Transportation System (NGATS). She is currently working on developing avionics and ground infrastructure requirements for conducting independent parallel approaches to closely-spaced parallel runways.

During the fourteen years prior to working at the Boeing Company, Ms. Alcabin spent five years doing airport consulting at both KPMG Peat Marwick and TRA/Black & Veatch, four years at the Center for Advanced Aviation System Development supporting the FAA Office of System Capacity and Requirements, and five years at NASA Ames Research Center working on what is now the Center-TRACON Aviation System. All of her projects have focused on developments to increase capacity and reduce delay in the National Air Transportation System.

Monica Alcabin has a Bachelor of Science degree in Aeronautical Engineering from the Massachusetts Institute of Technology and a Master of Science degree in Engineering-Economic Systems from Stanford University.

Tom Cornell. Mr. Cornell is a Director in the firm of Jacobs Consultancy in Burlingame, CA. He began his career with Leigh Fisher Associates and has more than 20 years of experience in airfield and airspace analysis, environmental evaluations, terminal efficiency analyses, and airport master planning. He returned in late 2005, after an eight-year absence, during which he served as Vice President with a U.S. airport planning firm.

Mr. Cornell has planned and evaluated numerous airport facilities and operational procedures, using his skills as an environmental and facility planner to develop innovative, practical, financially justifiable, and environmentally sensible solutions to airport problems. He has directed many assignments in airfield and airspace simulation and design, aircraft noise analyses, environmental processing, and economic evaluations. He also has led the facility requirements, facility planning, and capital improvement program efforts for many large-and medium-hub airport master plans. He has successfully prepared benefit-cost analyses for passenger terminals, airfield facilities, and ground transportation facilities. Mr. Cornell is known by his clients for providing practical solutions that meet challenging operational, growth, and environmental needs.

Don Crisp. Mr. Crisp is Vice President, Aviation Systems Analysis Division, of the ATAC Corporation. Mr. Crisp has over 39 years experience in airspace and airport operations, modeling and analysis. This experience includes 16 years as an Air Traffic Controller, four years in the United States Air Force (USAF) and 12 years in the Federal Aviation Administration (FAA). During this time, he worked in towers, TRACON, and oceanic air traffic facilities. Since joining ATAC in 1984, he has been involved in the development, analysis, and application of airspace and airport computer simulation models, automated aviation data processing tools, and in managing large-scale airport and airspace simulation and modeling projects using fast-time simulation analysis tools such as ATAC's Simmod *PRO!* and the FAA's Integrated Noise Model (INM).

Mr. Crisp began his career in the United States Air Force as a missile technician before switching to air traffic control. After eight years, he joined the FAA where he worked as a journeyman air traffic controller at several of the nation's busiest ATC facilities. Don joined ATAC in 1984 as subject matter expert on a project for development of the FAA's Advanced Automation System for air traffic control. He then began working as a key analyst, project leader, and program manager on large-scale airport and airspace simulation and modeling projects. Since being promoted to his current position in 2003, he oversees Airport Planning and Analysis projects and the development of the FAA's Performance Data Analysis and Reporting System (PDARS).

Dennis Sullivan (FAA). *To be provided at the meeting.*

Harry Swenson. Mr. Harry N. Swenson is the Principal Investigator for the new NASA Next Generation Air Transportation System (NGATS) Air Traffic Management Airspace Project. In this position, since January of 2006, he has been leading the technical proposal planning team to define NASA's research and contributions in support of the Joint Planning and Development Office (JPDO) NGATS vision while maintaining NASA's core aeronautics foundational sciences. Most recently he was the Project Manager for the Virtual Airspace Modeling and Simulation (VAMS) Project and the Chief of the Aviation Systems Technology Office since November 2002. In this position, he led the definition and analysis of advance Air Traffic Management (ATM) concepts, including the development of airspace modeling and simulation tools for system-wide analysis, as well as human-in-the-loop studies. During this period Mr. Swenson worked extensively with the newly formed, the FAA-led multi-agency JPDO assisting in the definition of advance ATM Concept and system-level benefits analyses for the JPDO NGATS Integrated National Plan.

Mr. Swenson joined the NASA-Ames Research Center in 1982 as a research engineer working on advanced helicopter guidance, navigation and control automation systems. He led several interagency projects with the FAA, Army and Air Force, researching issues associated with the Microwave Landing System, terrain following radar systems, forward looking infrared imaging systems integrated with heads-up and helmet mounted display systems, including the development and flight testing of a helicopter Terrain Following Terrain Avoidance System. In the early 90's Mr. Swenson transitioned his career to the research of ATM issues. He led the development of an ATM automation tool known as the Traffic Management Advisor (TMA) which he moved from a laboratory prototype into a the fully operational traffic flow management tool at the Fort Worth Air Route Traffic Control Center, serving one of the world's busiest airports. Based on this success, the TMA became one of the key elements of the FAA's Free Flight modernization program and is being deployed throughout the United States.

In 1998, Mr. Swenson became the Chief of the Aviation Operation Systems Development Branch, which developed, validated and tested all the NASA Center/TRACON Automation System software. His branch also ran several ATM laboratories, both at Ames Research Center and the North Texas Research Station in Dallas-Fort Worth FAA and Airline facilities. Mr. Swenson has authored 18 technical papers in the area of automation research and holds a B.S degree in Aeronautical Engineering from the California Polytechnic State University in San Luis Obispo and a M.S. degree from Stanford University in Aeronautics and Astronautics. He has been awarded numerous honors from NASA including the 1997 Software of the Year Award, the Administrator's Award for Turning Goals into Reality in 1998, the Exceptional Service Medal in 2002, and the NASA Outstanding Leadership Medal in 2004.